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2019-08

Muhammad , S , Lehecka , M , Huhtakangas , J , Jahromi , B R , Niemelä , M & Hafez , A 2019 , ' Meditation music improved the quality of suturing in an experimental bypass procedure ' , Acta Neurochirurgica , vol. 161 , no. 8 , pp. 1515-1521 . https://doi.org/10.1007/s00701-019-03976-4

http://hdl.handle.net/10138/325824
https://doi.org/10.1007/s00701-019-03976-4

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acceptedVersion

# Meditation music improved the quality of suturing in experimental bypass procedure

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**Acknowledgments:**

- We are thankful to Ehrnrooth Foundation for the Funding to first author (S M) for a clinical vascular and skull base fellowship, and for awarding the last author (A H) the C. Ehrnrooth Fellowship (Fondation de.Luxembourg) at the department of Neurosurgery in Helsinki.
- This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## ABSTRACT

**BACKGROUND:** Neurosurgeons are vulnerable to additional noise in their natural operating environment. Noise exposure is associated with reduced cognitive function, inability to concentrate, and nervousness. Mediation music provides opportunity to create a calmer environments which May reduce stress during surgery.

**METHODS:** A pilot study was performed to find suitable task, meditation music of surgeon's choice, operation noise and to reach a certain level of training. For the main experiment, two neurosurgeons with different microsurgical experience used real operation noise and meditation music with delta waves as mediating music. Each surgeon performed 10 training bypasses (5 with noise and 5 with music) with 16 stitches in each bypass. The total time to complete 16 stitches, number of unachieved movements (N.U.Ms), length of thread consumed and distribution of the stitches were quantified from the recorded videos and compared in both groups.

**RESULTS:** The N.U.Ms were significantly reduced from 109 ± 38 with operation room (OR)-noise to 38± 13 ($p< 0.05$) with meditating music in novice surgeon. Similar results were found if the experienced surgeon performed the same task [(from 29± 6.94 to 14 ± 3.36 ($p< 0.05$)]. The total time utilized for the sixteen stitches was slightly improved (not significantly) in novice surgeon and unchanged in experienced surgeon. However, the thread length used for 16 stitches was significantly different with OR-noise in comparison to meditating music in both surgeons. The distribution stitches showed a non-significant trend towards a uniform distribution with meditation music in both surgeons.

**CONCLUSIONS:** Meditation music of surgeon's choice is a simple method that improved quality of bypass suturing in experimental bypass procedure.



**Key words:** Operation Room, Noise, Meditation, Music, Neurovascular, Bypass


## Introduction

Neurosurgery includes many highly skill-demanding and stressful procedures, such as bypass surgery. The "stress rate" and drivers of stress are different for each neurosurgical procedure and for each neurosurgeon. Stitching during bypass surgery is one of the procedures, which holds high level

of stress. It necessitates a focused attention to achieve good quality in optimal time. The goal of high quality stitching in a short period of time can lead to stress and anxiety[11].

Environment, including the noise, in the operation room is an important factor specially in distracting surgeon's concentration and increasing the stress [14]. Stress is known to influence the heart beat variability and other vegetative function [33]. Hence, the strategies to reduce distraction, anxiety, and release the stress of the surgeon may be helpful to improve the quality of surgery

Meditating music may help to circumvent debilitating effect of stress on the fine motor skills of the neurosurgeon. Meditation and meditating music has been shown to relieve stress, and improve learning [1, 26]. There is increasing evidence that music attenuates symptoms in a variety of diseases including Parkinson's disease, dementia and attention deficit syndrome [23]. Intense pleasure in response to music activates the dopaminergic system in striatum and mesolimbic system. Dopamine release in the central nervous system has implication in combating stress [28, 29]. The dopaminergic and serotoninergic deep nuclei are linked to the motor cortex supporting the possibility that fine motor skills might be influenced by the meditating music. Evidence from literature supports the notion that sound, the auditory system and the motor system are interconnected and hence may control the fine motor movements [10, 37].

We aim to investigate the influence of meditating music and compared it with the influence of operation room noise on surgical performance. We introduced meditating music on our already established experimental bypass surgery to investigate the difference in quality of suturing during OR-noise and meditation music of surgeon's choice.

## Materials and methods

We recorded the videos of stitching artificial vessels and investigated different parameters to quantify the quality of bypass suturing. These parameters included unachieved movements of surgeon, distribution of the stitches, time utilized and total length of thread used for sixteen microsurgical stitches. These parameters were evaluated in an environment with routine operation room noise in comparison to meditating music. We investigated the above-mentioned parameters in two surgeons with different training experience. The experiment was conducted at the Neurosurgical Department in the Helsinki University Hospital, using an OPMI PENTERO 900 ZEISS inside an OR (Fig.1A)

In this experimental study, all training tasks simulating bypass suturing were end-to-side procedures. The tasks were performed by first author (S.M), a fully training EU board certified neurosurgeon

(2017) worked as a clinical fellow in neurovascular and skull base microneurosurgery for one year (2018), and the last author (A.H), who finished his residency 20 years ago and who has performed 1,500 different experimental bypass procedures over past 4 years, between June 2014 and July 2017, in the Department of Neurosurgery, Helsinki University Hospital, Helsinki, Finland**.**

**Experiment Design**

A vessel wall suturing procedure was simulated. The two participants were asked to suture an already cut in scaphoid-shaped silicon tube. They were required to distribute 16 stitches with four knots.

We designed our model by developing a shape similar to the shape of bypass suturing end-side interrupted stitching. The shape was developed, using a millimeter paper (Fig. 1B). We chose the 4mm diameter tube and 16 stitches to be used with 4 corner stations, which allow measuring the distances between stitches, which perfectly supposed to be one millimeter (Fig. 1C).

The participants were asked to suture in the same order; the numbers (1 to 4) in the model were used to keep participants direction and order of suturing (Fig. 1B). The magnification during suturing was (8 times) in all 20 cases.

We used same 9-0 suturing material (PROLENE, 13 cm, 5.0 mm, 3/8c, ETHICON) and same micro-instruments (i.e. scissors, needle holder and forceps) in all procedures (Fig 1A).

All videos were analyzed blindly after finishing all the cases. Suturing time was measured from video. The length of thread consumed by the procedures was measured by measuring the length of remaining thread. The repeated movements, which did not achieve the intention goal (e.g. catching the needle, catching the tube wall with tweezers) were counted carefully from videos. The distribution of stitches was quantified by giving a score based on the uniformity of distribution (distance between each stitch) of 16 stitches on the vessel wall (Figure 1C).

**Statistical analysis:**

The data were analyzed using GraphPad Prism 5.00 (GraphPad Software, San Diego, CA, USA). After testing for normality, unpaired t test and welch, s correction was performed in case of non-normal distribution to compare two groups.

Data is expressed as mean± SEM, a p value $< 0.05$ was considered as significant difference.

**Results:**

Results of video analysis of the procedures for novice surgeon and experienced surgeon using original operation noise and meditating music are summarized in table 1. Interesting, the N.U.Ms were significantly reduced from 109. ± 38 with OR-noise to 38± 13 ($p< 0.05$) with meditating music in novice surgeon (Fig. 2 B). Similar results were found if the experienced surgeon performed the same task. The N.U.Ms was reduced from 29± 7 to 14 ± 3 ($p<0.05$) showing that meditation influenced positively the surgeons motor skills independent of experience and training (Fig.2 A &B). Stitch distribution did not differ significantly (Fig 5 A & B).

Moreover, the length of thread used for the sixteen stitched was significantly reduced from 8 ± 1 cm with OR-noise to 5± 0.46 ($p< 0.05$) with meditating music in novice surgeon (Fig. 4B). Similar results with significantly less use of thread for 16 stitches was quantified in experienced surgeon (Fig. 4A). showing a reduced length of thread needed for 16 stitched from 9 ± 0.42 cm to 7± 0.45 cm ($p<0.05$) (Fig. 4 A & B). The total time utilized for the sixteen stitches was slightly improved (not significantly) in novice surgeon (Fig. 3B) and unchanged in experienced surgeon (Fig. 3A). Interestingly, the N.U.Ms fluctuated during the OR-noise and they were less fluctuating with meditating music over the time of five repeated experiments (table 1).

**Discussion**

This study assessed the influence of meditating music on the performance of the neurosurgeons, recruiting the highly demanding procedure: the bypass.

Meditation may reduce the stress and influence the motor skills of surgeons. However, music and task is a complex field and may depend on personality of surgeon, choice of music, and other many other factors. Up to our knowledge this is the first study showing improvement of the quality of stitching with music in an experimental setting.

Previous studies showed the intervention of external distraction on the neurosurgical performance [13, 14]. Noise is a known health hazard leading to stress, and decrease the concentration [15, 30]. Relaxing atmosphere of the operation room might be a factor, which helps surgeon to achieve better performance.

The meditation has been shown in various studies to influence different brain areas [5, 9, 33, 35]. It has been used to reduce the stress, anxiety and depression in patients and in healthy individuals [21, 31]. Music is known to have influence on the mood and physiological responses [2, 29]. It has been used as an independent nursing intervention for preoperatively in patients having day surgery [7].

The trainees experience a different levels of stress and anxiety before and during surgical procedures [3, 12, 22]. Neurosurgical operations hold high level of anxiety, demands certain level of hand-eye coordination, and fine manipulation [4, 6, 8, 17, 36].

The senior and expert neurosurgeons compete better with complex surgeries and stressful situation than novice ones [5, 16]. In contrast, at the time of new resident the operation room noise and movement levels are changed dramatically. Opposite to the norm and trend, in which the seniors get more calm atmosphere, the novice and less experience neurosurgeons in need of more comfortable and less noisy operation room[14].

Meditation and meditating music is becoming increasingly popular and achieving scientific support [20]. It could help in stressful circumstances and overcoming part of the anxiety associated with surgical procedures. Our study showed that meditating music improved the quality of bypass independent of training level. Fortunately, not all neurosurgical procedures hold such high level of challenge with associated anxiety and stress. Hence, the result could be less dominant in simple routine and daily procedures.

The comfort and relaxed hearing voice (meditating music) may improve efficiency and decrease the operative time. Our results showed improved efficiency measured by number of unachieved movements during surgery (Fig.2 A & B). However, our result showed only a trend toward improved time (Fig 3 A & B). The comfortable voice and experience of the surgeon are directly related, and the lack of experience would translate directly to slower, more hesitating movement, and less flexibility. In our experimental task the less experience neurosurgeons saved more length of the thread but consumed extra time and repeated more unachieved movements (Table 1).

Meditating music is well established as a way of adjusting the animal and human behaviors [19, 32, 34]. However, different meditation forms could affect different cognitive processes [20]. Using

meditating music could calm body movements and optimizes movements, which help in achieving better motor performance [24].

Music acts as non-pharmacological intervention that attenuates a variety of symptoms in various diseases, such as Parkinson's disease, atrial hypertension, dementia, and attention- deficit/ hyperactivity disorder [23]. It changes the concentrations of dopamine, serotonin in deep brain nuclei linked to the motor area [37]. The relationship among sound, auditory circuity, and motor systems which control the fine movements is well established in the literature [37]. The hearing stimuli has a remarkable ability to drive rhythmic, metrically organized motor behavior [25, 27].

There are inevitable background noise in operation room as well as distractions [18]. Our older study proved the difficulty of engaging in a secondary task during surgery and the negative impact of the voice distraction [14]. The experienced neurosurgeons could compensate the stress of operation atmosphere including the noise. However, the type and the level of distraction in one hand, and the level of the complexity of the procedure in other hand cannot be ignored. When the procedure is high -skill demanding, such as bypass neurosurgery, the external stimulation becomes crucial.

Our data with some limitations show that performance was worse during practicing bypass under the influence of operation room noise compared to the meditating music. The effect was different between the two subjects (neurosurgeons), based on the past experience with the procedure. Even with extra attention paid by neurosurgeons to complete the task, trying ignoring the sound of the operation room, still the irritating sound reflected the performance as well as laid its effect on the results. The price of the noise and the benefit from the meditating music reflected on the number of unnecessary movements before achieving the intentional goal (Fig2 A & B). For example; penetrating the wall of the tube, tight the stitch, holding the needle, and others.

Finally, even with small number of procedures, learning curve and adaptation with the noisy operating sounds were noticed in our trial. The individual endurance level of tension and ability to cope with noise distraction stands behind differences in handling such matter in our field.

**Limitations**

The main limitation is that this study includes a limited number of surgeons; only two surgeons involved, and no randomization of the exercises. Therefore, the results might partially reflects their personal traits and the different volume of bypass training they underwent previously. Moreover, repeating the task and learning effect (learning curve theory) could influence the result.

Although it is attractive study with important findings, it is less realistic than naturalistic observation. Although suturing style and designed task are recruited from bypass procedure, this task does not simulate all the bypass steps. This study covers a narrow corner in everyday neurosurgical practice. However, it is part of a series of studies focusing on the training quality in neurosurgery.

## Conclusions

We conclude that the noise influenced performance of the surgeon, especially when performing complex task such as bypass procedure. The meditating music could positively impact the automaticity of surgical performance. Level of noise and experience of the neurosurgeons can affect the outcome of the surgery. To achieve better outcome, the noise level inside the operation room and use of individual meditating music may be considered

**Table 1.** Video analysis of different factors to quantify the quality of bypass procedure for (Novice surgeon), (experienced surgeon), using recording of real operation noise and meditating music

## Figure legends

**Figure 1A.** Experimental setup and the surgeon and microscope inside the OR. Video recording of bypass suturing, designed task, and silicon tube and suturing instruments are seen on the screen.

**Figure 1B.** Schematic view of the suturing task. The diamond-shaped "rhombus" with 4 mm length of its four sides (red arrow). The tube diameter also is 4 mm. The axis located in this direction. The numbers (1, 2, 3, and 4) was sutured first in order and then starting from number 1 clockwise (black curved arrow) to complete the 16 stitches at the end. The background of the design is a millimeter paper was used after suturing to analysis the result.

**Figure 1C.** Suturing sample captured from a recorded video, after completion of experiment we used the millimeter paper to examine the distribution of the stitches.

**Figure 2.** Number of unachieved movements with operation noise and after meditating music in both; experienced surgeon (A), n=5, unpaired t-test ($p=0.0027$) and novice surgeon (B), n=5, unpaired t-test ($p=0.017$)

**Figure 3.** Time of suturing with operation noise and after meditating music in experienced surgeon (A), n=5, unpaired t-test (p=0.52) and novice surgeon (B), n=5, unpaired t-test (p=0.27)

**Figure 4.** Length of thread used with operation noise and after meditating music in experienced surgeon (A), n=5, unpaired t-test (p=0.0001) and novice surgeon (B), n=5, unpaired t-test (p=0.017)

**Figure 5.** Distribution of stitches with operation noise and after meditating music in experienced surgeon (A), n=5, unpaired t-test (p=0.073) and novice surgeon (B), n=5, unpaired t-test (p=0.57)

**Conflict of interest:** All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest, or non-financial interest in the subject matter or materials discussed in this manuscript.

**Compliance with the ethical standard**

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- Funding-No funding was received for this research.

- We are thankful to Ehrnrooth Foundation for the Funding to first author (S M) for a clinical vascular and skull base fellowship, and for awarding the last author (A H) the C. Ehrnrooth Fellowship (Fondation de.Luxembourg) at the department of Neurosurgery in Helsinki.
- This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

- Author (S M) declares that he has no conflict of interest. Author (A H) declares that he has no conflict of interest.

- All other authors declare that they have no conflict of interest.

- Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Refereces

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